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Drawings by C. P. Meier

Exploration of Space:

For Man's Benefit -- or Detriment?

Exploration of space moved from science fiction to fact when it became a national objective.

In the United States, President Eisenhower announced on July 29, 1955, that we would presently be launching an instrumented earth satellite as a part of the International Geophysical Year program.

Russia announced in 1956 that the U.S.S.R. was working at the same thing.

Perhaps not many people took this seriously at first.

But when the satellites started flying, the whole world sat up and took notice.

The first Soviet satellites, Sputniks I and II, began to orbit around the earth on October 4 and November 3, 1957. On January 31, 1958, the Explorer, first U. S. satellite, started circuiting.

The intensity of public interest throughout the world left no doubt of man's profound emotional reaction toward the opportunity of widening his horizons by venturing into space.

Since these beginnings, the effort to explore and exploit space has grown tremendously.

Successful attempts to reach the vicinity of the earth's natural satellite and send back data were made early in 1959 when in January the Russians fired an instrument container past the moon and in March the United States accomplished a similar feat.

On September 13, 1959, the first solid object sent by man from one cosmic body to another reached its destination when a hermetically sealed instrument container weighing 858 pounds, launched by the Soviet Union, smashed to pieces against the moon at a speed of about 7,500 miles an hour at the end of a 236,160 mile journey.

Back of these feats and those yet to come stand, in long succession through the years, the scientists and engineers of many nations whose accumulation of knowledge has made such accomplishments possible.

In a democracy, the citizen footing the tax bill has the right to ask questions:

Are such efforts necessary and justifiable?

Are they organized efficiently?

What benefits to mankind will come from them? What harm, if any?

Will exploration of space bring large expenditures indefinitely with no expectation of financial return?

Will it tend to calm the nerves of a troubled world or cause new tensions and misunderstandings?

There is also the more elementary question:

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JUST WHERE DOES SPACE BEGIN?

Space is perhaps best defined in a practical sense as beginning at the level above the earth at which free, unpowered flight of satellites can be maintained for a significant number of revolutions before falling back to earth.

This level is between 100 and 150 miles.

At 100 miles the atmosphere is sufficiently dense to end the career of a satellite after orbiting only a few revolutions. At 120 miles, the satellite will do more than 100 turns around the earth. At 150 miles it will orbit for many thousands of revolutions.

TYPES OF SPACE EXPLORERS

Space activity can be divided into three categories: by rocket, by satellite, and by space vehicle.

Rockets penetrate into space then fall back into earth's atmosphere. Equipped with scientific instruments, they are used to explore a cross section of the atmosphere and magnetic field, and to probe into outer space.

Rockets are also used for launching atomic bombs against military targets.

Hundreds of exploring rockets were launched during the recent International Geophysical Year (IGY) by both the U.S.S.R. and U.S.A. These culminated with Pioneer I that reached a height of 71,300 miles and Pioneer IV that became a space vehicle since it went into solar orbit.

The second category—artificial earth satellites—can be put in orbit by rocket launchers at any height between 100 miles and several million. Orbits below 22,700 miles circle the earth in less than one day. Above this level, a complete orbit requires more time. The moon at 238,000 miles takes about 28 days to orbit the earth. An artificial satellite at 22,700 miles would orbit in 24 hours. Such a satellite would therefore encircle the earth at the same rate as the earth rotates on its axis. This is very important and useful for the following reason. If launched eastward at the equator, such a satellite will hover over a fixed point on the equator. If launched eastward from a site to the north or south of the equator, it will oscillate slowly each day over an arc. Thus such a "hovering" satellite will remain continuously within view of fixed points over about half of the earth's surface.

Space vehicles—the third category—are launched to operate free from the earth's gravity. Return to earth occurs only by control and deliberate guidance of the vehicle. The Soviet Mechta and the U. S. Pioneer II are examples. Such space vehicles will be used to explore interplanetary space and the moon, the planets, and the sun.

WHY THE INTEREST?

This question pretty much answers itself. But to be more specific, our interest is for scientific, commercial, and military-political reasons.

Space exploration promises a wide variety of scientific advances that can be achieved in no other way. It will increase man's knowledge of the earth. It will add greatly to what we know concerning the earth's environment in interplanetary space. Eventually it will increase our understanding of the origin, history, nature, and development of other bodies of the solar system, with possible discovery of independent origins of at least elementary forms of life on other planets.

Obviously, space exploration will depend on what science learns about our space environment. For example, man cannot safely traverse space until radiation effects are fully mapped and understood.

Scientific exploration of the earth itself by means of instrumented satellites holds immediate promise. Already the Vanguards are providing new knowledge of the shape or "figure" of the earth. This information is useful not only for more precise mapping but extends our knowledge of the atmosphere and ionosphere surrounding the earth.

For instance, satellites provide an effective means of scanning the cloud cover of the earth, and deducing the formation, movement, and disintegration of storm systems from the look of the cloud tops. Even more important will be measurement and mapping of the heat inputs from the sun and outputs from the earth as they change with changing cloud cover from day to day. These inputs and outputs provide the energy that generates the storm systems that give us our weather. Heat-balance data provided by satellites may well revolutionize our knowledge of atmospheric behavior and permit more precise forecasting of weather. Such data might even enable us to learn how to control weather. Benefits like these could well repay the whole cost of our space program.

Exploration of the earth's environment has already revolutionized our concepts of the geomagnetic fields of earth and space. We have found out that the magnetic field of the earth is far less simple than supposed, and is influenced by wandering magnetic fields in space. Magnetic changes produce disturbances at the earth's surface known as magnetic storms. Such phenomena, of course, have profound effects on long-range radio transmission.

The science of astronomy is also being revolutionized. With stabilized satellites and improved telescopes, our examination of the stars and intervening space will give us an entirely new view of the universe. Before space science, only limited windows were available from beneath the atmosphere.

As for interplanetary travel, over and above the adventure itself, and quite apart from the possible advantages of occupying other planets, the scientific knowledge to be acquired is prodigious. That there are some forms of life on Mars, for example, seems quite certain, since the temperate zones on Mars appear to get green in summer and brown in winter. But there is no free oxygen and little water on Mars, so the character of life is somewhat of a puzzle. Perhaps life on that planet has made use of quite different evolutionary paths. Exploration of Mars might provide basic keys to the origin of life itself and give us some notable surprises.

To get to Mars and other planets, our efforts will probably follow a pattern like this:

1. Lunar, interplanetary, and solar probes to circle the moon, Mars, and Venus, and perhaps penetrate close to the sun, to transmit back their scientific findings.
2. "Hard" landings of certain durable experiments on the moon and planets.
3. "Soft" landings of permanent or semi-permanent experiments that transmit data back, and possibly their automatic return to earth with samples. This would amount to a "mechanical space-man."
4. Short-range experiments of man in space, perhaps in a few satellite orbits.
5. Soft landings of man on planets with reasonable probability of return. By this stage, a wide range of safety measures must have been developed and tested.
6. Establishment of planetary bases. Such bases could conceivably be manned by a series of soft landings without immediate expectation of return.

This is a long and difficult program. It will require time. Yet it seems capable of being carried out within the remaining years of this century.

SPECIAL USES

The advance of human knowledge from exploration of space should repay the effort in many ways. And there could be disadvantages, too.

Commercial. For the more distant future, satellites seem likely to provide quick transportation around the earth between distant points.

In the very near future, the use of satellites for commercial communications can be foreseen. A variety of methods are feasible. A large satellite, such as a balloon with a metallic surface, can be used to reflect very-high and super-high radio frequencies over extremely long ranges. The hovering satellite becomes especially important for such service since it can be stabilized in the view of any two selected terminals. Using highly directive antenna systems at the communication terminals, a large number of communication satellites can be in view simultaneously without interference. In this way our entire present communication capacity can be multiplied by a hundred for each communication satellite put in use. Moreover, fading as now encountered will be eliminated.

Through satellite relays, a revolution in long-range transmission can be foreseen. While a satellite relay system with its terminal equipment may cost $100,000,000, it has the economic potential of recovering the initial cost each year for many years. Cheap long distance communications and international television will become feasible.

But first, problems of radio frequency allocations will have to be worked out among the nations.

The International Telecommunications Union (ITU), acting under the United Nations, is the world agency that seeks to set up principles of radio frequency allocations for use among the nations. The very high frequencies (1,000 to 15,000 megacycles), that will become most useful for relay by satellite, have already been allocated to nations for local services. This was done because, before the space age, these very high frequencies could be used only over short ranges of distance. The satellite relay system will change all that. But because the most suitable wave lengths for satellite relay have already been assigned to other uses, we are faced with a formidable problem. For instance, in the United States, these radio frequencies have in most cases been allotted by the Interdepartment Radio Advisory Committee and the Federal Communications Commission for military and for civilian commercial use. These allocations now represent large capital investments for local services of a great variety, such as taxicabs, mobile telephone, police and other short-range communications, as well as radar, aircraft navigation, and so forth. To clear the way for the coming and much more valuable communications method, large bands of several hundreds or even thousands of megacycles will have to be cleared of existing short-range communications. Moreover, to make way for services thus displaced, much tighter standards must be adopted over the whole spectrum, requiring almost complete reinvestment in improved apparatus. Changes like these will of course be resisted by services now using them that have large investments in existing low-grade equipment not only in the bands that will need to be cleared, but also in the adjacent bands to which displaced services will have to be shifted.

Therefore, the speed with which inexpensive satellite communication becomes available will be largely dependent on the speed with which new allocations can be agreed on.

This question of how to get agreement and enforcement as to allocations, so that we may enjoy the benefits of satellite relay communications, represents but one of the many complicated problems that face us in the age of space.

Military and Political. Space technology has already produced a situation where the threat of annihilation hovers over the nations.

Will there be space warfare?

Or will mankind be sufficiently wise to reach agreements that will make the most and best of space?

Whether for war or peace, a successful space program has become the symbol of world leadership.

Prior to Sputnik I, we had not caught on to that fact.

Now we are fully aware of it.

ORGANIZATION OF U. S. SPACE ACTIVITIES

The Space Council. Under the Space Law of 1958, the policy under which all U. S. space activities are directed is formulated by the U. S. Space Council. It is composed of the President, the Secretary of State, the Secretary of Defense, the Chief of the National Aeronautics and Space Administration, the Chairman of the Atomic Energy Commission, and four additional members, Dr. Detlev Bronk, Dr. William A. Burden, Dr. John Rettaliato and Dr. Alan Waterman, representing different governmental and non-governmental activities and agencies.

Civilian Activity. The same law focuses development of all civilian interests in space technology through the National Aeronautics and Space Administration.

The NASA includes among its purposes the encouragement of space science carried on by the nation's best scientists. As a way to bring this about, the NASA hopes that at least 80% of such activity can be developed through arrangements with scientists and institutions outside of the government. Of great importance, for instance, is cooperation with such groups as the Space Science Board of the National Academy of Sciences.

The best way to develop commercial interests under NASA is not so clear. What should procedure be, for instance, in the field of communications? Setting up a system of communication satellites, which involves launching sites for them, and launching rockets, will be very costly—probably too costly for any individual commercial enterprise to undertake. Should the government therefore supply the entire satellite communication system?

This idea runs counter to our system of free enterprise.

Should the NASA launch and maintain the system, leasing given bands of wave lengths to particular commercial enterprises?

Should the satellites be commercially constructed, then launched by government facilities?

How ought this to be worked out?

Military Activity. Such activity comes under the Department of Defense.

The Department has given the Air Force the primary job of carrying on our military space program, with the Army and Navy responsible for assigned special projects. The Advanced Research Projects Agency, originally set up in 1958 to meet demands for coordinated action, will still carry on research. It remains to be seen whether these arrangements will best serve us.

Another consideration: should Voice of America broadcasting and television be carried on by NASA as part of its development of satellite communications? Or should this be done with military support, thus developing parallel systems? A case can be made out for the latter, since the military has always had its own communications system. If they set up their own, should it be a defense-wide system? The services now have separate ones. They may argue that each should have its own satellite communications system. This could give the U.S.A. four or five satellite systems.

Clearly these problems deserve the most careful consideration.

INTERNATIONAL

The harm nations could cause one another through space, as well as the benefits, make space activity an international problem.

At U. S. suggestion, a United Nations Committee on the Peaceful Uses of Outer Space has been set up.

Though the Soviet Union refused to take part, this U.N. Committee held sessions in May and June of 1959 to under-

take preliminary studies and make reports. Of particular concern to it are measures of international law which could bring to mankind the greatest benefits from space exploration and utilization.

Just why the Russians failed to cooperate at this time is not at all clear, since taking part would seem much to their advantage. Perhaps their fear of disclosing rocket• secrets through the Committee is a further sign of their overwhelming wish for internal security. Perhaps they feel that since they launched the first Sputnik, they should be able to dictate the terms of international space usage.

However that may be, the free world has no alternative at present but to deal with its space problems in the U.N. minus the Soviet Union.

At least the Soviet Union retains a position in several member unions of the International Council of Scientific Unions (the ICSU, which organized the International Geophysical Year). Through its membership in these groups, the Soviet Union will presumably at least continue limited cooperation. But, as in the U.N., Russia is still not taking part in the work of the ICSU's Committee on Space Research (COSPAR).

The Soviet Union participates also in the annual world conferences on space activity held by the International Astronautical Federation in which scientists of all space-minded nations take part. But Russia's non-participation in COSPAR, like her non-participation in the U.N.'s committee on space, remains a source of world tension and seems certain to react counter to both Russian and world interests. COSPAR, for example, is working for useful space cooperation between nations that have abundant space facilities and those that cannot afford them. The U. S., through arrangements undertaken by COSPAR, has already offered space in scientific satellites to scientists of "have not" nations.

Meanwhile, the work of both committees continues in a way that will permit Soviet adherence should the attitude of the U.S.S.R. change.

An indication that the Soviet Union policy may be changing in the direction of greater cooperation is perhaps to be seen in the fact that, soon after the launching of its successful shot to the moon, the Soviet sent to the World Warning Center at Fort Belvoir, Virginia, announcement of the radio frequencies being used.

SPACE LAW AND REGULATION

The present breakdown of international negotiations looking to agreement, planning, and regulation of space activities has left a situation where, in the words of the Congressional Select Committee on Astronautics and Space Exploration, "the world will be operating in even more of a political-legal void, so far as space exploration is concerned, than it has in the past."

When space is used for the military, political, and commercial advantage of one nation to the disadvantage of another, there's bound to be trouble. The present situation is inherently dangerous. With the passage of time, tensions are certain to increase in relation to national interpretation or misinterpretation of coming space events. Misapprehensions will grow as unagreed launchings of space vehicles assume a more and more threatening aspect of national power.

Under the present circumstances, the Select Committee of Congress recommends the following steps toward space law and regulation:

1. Begin now with the development of rudimentary space law.
2. Identify and concentrate upon the most urgent areas which show some promise of settlement.
3. Attempt agreement on principles and on methods of settling disputes, leaving specifics for a later date when necessary.
4. Emphasize agreements on scientific and commercial uses of space, working from these toward the larger issues, such as national sovereignty.

A little thought on the matter shows that tremendous problems and decisions lie ahead.

While active international negotiation concerning space does not now seem possible because of the Russian attitude, are we ourselves prepared to carry on such negotiations when the time arrives? Do we fully enough understand and have we sufficiently studied the major implications of what lies ahead in space?

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